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Habitat Guilds

Habitat-Based Guilds

Wildlife-Habitat Relationships and the Formulation of Habitat-based Guilds

To incorporate wildlife and vegetation into a sustained yield plan requires three steps, discovery of the nature of the wildlife and vegetation, prediction of the response of this biota to candidate management actions, and use of predicted responses as cost factors or constraints in the choice of a final management plan. This report addresses the first and second steps. Two problems prevent the accomplishment of the first step by simple tabulation of the species occupying a landscape; the wealth of natural history information for all species taken together is too large to enter into any conceivable management planning process, and for all its size this corpus of data contains, for many species, only the barest outlines of their natural histories and habitat requirements.

Three candidate approaches exist for reducing the complexity of the total biota. The first is to use the federal and state endangered species acts to decide what should represent biodiversity. It is common knowledge that some fraction of species listings are not motivated by concern so much for the species themselves as for concern for the species' putative habitats. Were this the case for the listed species living on PALCO's lands, one might follow this approach to conclude that a sufficient conservation strategy could be arrived at by concentrating solely on the needs of this small subset of the biota. We rejected such an approach on the grounds that listing a species inevitably requires an assessment that its population is low or declining. No scientific logic demands that species with low or declining populations be necessarily representative of a significant fraction of the local biota. Perhaps more troubling, listing a species solely as a means of preserving biodiversity requires an a priori judgment that the habitat of that species is a particularly important habitat. In our opinion assessment of the relative importances of different habitats in a particular landscape is not a task that can be done entirely from the literature or from theoretical reasoning; it requires local data, carefully collected.

Another approach` to simplifying biodiversity management involves identification of management indicator species. These are species selected to represent particular habitats. The use of management indicator species is a reasonable approach, but the identification of such species requires an appraisal of what habitats are important and what species best speak for them. This would require a great deal of time, research, and discussion within the scientific community. We agree with the report of the Wildlife/Science Committee to the Board of Forestry (Pendleton 1994) that if management indicators are to be used for sustained yield plans, then a process needs to be established at the bioregional level by which the scientific community identifies them.

A third approach, the approach taken in this report, is to aggregate species into groups that require similar ecological conditions. The term "guild" is used in community ecology to describe a group of species that use a particular class of resources. The original point of identifying a guild of species was to permit examination of the processes that influenced evolution and community

dynamics within the guild, but the concept of a guild is also useful for identifying species with common vulnerabilities. All members of the guild of hole-nesting birds, for example, are vulnerable to the elimination of dying trees and snags. We use the term "habitat guild" to describe species that might be expected to suffer if a particular forest habitat type were eliminated.

Landscape Scale

Before identifying habitat guilds, we must discuss briefly landscape scale and pattern. This issue has loomed large in the recent scientific literature. The report of the Ecological Society of America on ecosystem management (Christensen, et al. 1996) identified scientific concepts and actions essential to intelligent ecosystem management. A prominent component of these is recognition and management of processes operating on different spatial scales.

The choice of the proper landscape scale at which to manage for biodiversity is not obvious. Relating forest management activities at any scale to their impacts on the total biotic community is a fairly new research topic. Traditionally forest wildlife biologists were primarily interested in impacts of management activities on game populations. In the last decade that emphasis shifted in the western United States to assessing impacts on threatened and endangered species. Only recently has attention turned to biodiversity in general. The practical consequence is that one finds oneself working on the edge of the ecological sciences, where methods are still being developed and management goals are often unclear.

Two different landscape scales for assessing management impacts seem obvious from the literature. The older, more established approach concentrates on discovering the relationships of various species to an individual habitat type at the scale of the forest stand. The consequences for a species or guild are assumed to follow from the impacts of management on the gross quantities of the habitat types upon which it depends. This approach is typified by the California Wildlife Habitat Relationships (WHR) System (Mayer and Laudenslayer 1988).

Most research of the older school has been devoted to the influence of forest management on vertebrates in eastern forests (Wigley and Roberts 1994). Petranka et al. (1993) found that clearcutting reduced the diversity of salamanders for a period of 50-70 years. A similar pattern was exhibited by small mammals in the northern Appalachians (Kirkland 1977); clearcutting initially reduced the number of species, but diversity increased through the sapling and pole stages of regeneration. A great deal of research has treated the effects of timber management on birds. It tends to show similar patterns, although Welsh and Healey (1993) actually found that the diversity of birds was greater under even-aged management than on unmanaged areas. The avifauna in the east seems particularly sensitive to riparian-zone management; Stauffer and Best (1980) discovered that 70-78% of breeding bird species occurred in narrow riparian strips (< 50 m). Taken together these patterns have led some ecologists to suggest that forest management and biotic diversity can be accomodated simultaneously with creative silvicultural (Lennartz and Lancia 1987).

Northern California forests (especially coastal Douglas-fir communities) have long been assumed to conform to the traditional model of Northwest forest dynamics. In this model structural complexity is thought to build over time after some catastrophic disturbance and is thus better developed in old-growth than in younger seral stages (Edgerton & Thomas 1978 , Manuwal & Huff 1987, Meslow 1978, Wiens 1978). A more recent perspective suggests that low- and moderate-

intensity disturbances (tree deaths; low-intensity fires) are at least as frequent as catastrophic events, and that by converting canopy trees to snags and logs, and by creating canopy openings and bare soils, they enhance structural and species diversity within all natural forest stages. Hansen et al. (1991) reviewed evidence for this point of view from a number of studies of plant and wildlife communities in Douglas-fir forests in the coastal Northwest, including northwestern California.

The biodiversity consequences of change in western forests have been variable, ranging from no effect of successional stage on wildlife diversity, to small effects on diversity, to "...species diversity increases as forest succession advances toward maturity..." (see Edgerton & Thomas 1978). Conclusions from two studies changed during the courses of the studies themselves (Raphael 1984, 1988, 1991, Welsh & Lind 1988, 1991). Adding to the variability, different studies have measured species diversity in different ways and have focused on different taxonomic groups.

In contrast to the traditional school of forest wildlife ecology, a newer approach accepts the findings of the older approach at the spatial scale of the forest stand but adds to it concern not just for the amount of a particular habitat but for its arrangement on the larger landscape. This landscape approach to forest wildlife management originated with concern over forest fragmentation (Saunders, et al. 1991). Studies of vertebrates living in the eastern deciduous forest indicated that while total species diversity may remain unchanged or even be higher in managed forests (Enge and Marion 1986, Mitchell and Lancia 1990) interior forest species were in decline and forest edge species were increasing (Whitcomb, et al. 1981, Robbins, et al. 1989, Terborgh 1989).

The extent to which landscape-scale research on eastern forests can be generalized to western forests is currently a matter of discussion (Hejl 1992). The patterns of landscape change are not entirely comparable. Fragmentation of the eastern deciduous forest has been much more severe, with very large areas showing patches of forest remaining as habitat islands in a matrix of land cleared for agriculture and urban development. Forests managed for commercial production of timber in the West, by comparison, retain timber as the dominant landscape matrix; clearings are the isolated patchy structure. The clearings themselves are different; they are smaller, particularly in California, and ephemeral. Unlike farmland or urban areas, western clearings become brushy within a few years after harvest, quickly softening the edges of adjacent forest stands as well as providing secondary habitats.

The greater topographic relief and the fire-dominated dynamic processes that characterize western forests have combined to produce patchy effects even in the absence of commercial forestry. These processes are different from the gap formation processes dominant in eastern deciduous forests, suggesting that one might expect a different set of evolutionary responses to a patchy landscape among the plants and animals that occupy western forests.

These and other differences between eastern and western forests and their biotas have led some to conclude that application of the emerging concepts of landscape ecology to the western forest is premature (McGarigal and McComb 1995). What is needed first is a series of basic empirical studies that relate landscape patterns in western forests to the biotic communities they support. Even a few theoretical ecologists have started to wonder whether the dominant ideas of landscape ecology might have been injected into the policy arena prematurely. Simberloff, et al.

(1992) observed, for example, that "a remarkable publicity campaign, much of it outside the bounds of mainstream science, has promoted corridors for conservation."

The study by McGarigal and McComb (1995) is particularly important in this respect, since it is one of the first to examine the relationship of landscape metrics to the wildlife community in western forests. After examining the avifauna associated with late-seral forests in the Oregon Coast Range, it concluded that

> ...without exception habitat area was more important than habitat configuration. Thus, with the exception of a few "edge" species, variation in abundance among landscapes was more strongly related to changes in habitat area; habitat configuration was of secondary importance.

and

> Contrary to the idea that habitat fragmentation is detrimental to species that specialize on a particular habitat, most species that exhibited significant relationships with habitat configuration in our study were associated with the more fragmented distribution of habitat ....

The authors did not support the notion that biodiversity patterns at the level of the landscape are nothing more than the sum of biodiversity patterns at the level of the forest stand; they concluded only that the rules inferred from the study of eastern deciduous forests may not be the rules governing landscape-level habitat patterns in the West.

This brief review of forest landscape ecology suggested to us that while there may be rules by which one might create a landscape-scale design for biodiversity protection on PALCO's lands, those rules are not yet known to science. Until they become known, a reasonable biodiversity plan should provide both for adequate representation of the entire spectrum of forest habitat types and for research designed to discover where patterns in the larger landscape are having an impact.

PALCO'S Forest Habitats

What makes for adequate representation of the spectrum of forest habitats requires a bit of discussion. We base this discussion on two lines of inquiry. The first is the series of broad-spectrum biodiversity surveys PALCO began in 1995 (Volume II, Part K). The second is a review of the scientific literature. Each approach has strengths and weaknesses.

The literature suggests that the coastal forests of northern California are fire-dominated ecosystems (Brown and Swetman 1994). Low-intensity fires burned through these forests at intervals of seven to 25 years, removing undergrowth and small trees (Stuart 1987). At intervals of 500 years, on average, large, stand-destroying fires killed all the trees and created forest openings (Franklin and Dyrness 1973). Starting from this condition, we categorized the phases of forest growth on PALCO's lands into five seral stages, from forest openings to old-growth forests. PALCO's ownership also has extensive areas of natural grasslands and hardwood stands that are not part of the successional sequence.

The forest-opening seral stage is characterized by grass, brush, and seedling trees. It is quite

short in this region, five to 10 years, and terminates when young trees are about one inch in diameter. The young-forest stage comprises sapling trees from one inch to 11 inches in diameter. This stage lasts from 10 to 20 years. Mid-successional forests consist of trees with average diameters from 12 to 24 inches. Such forests are usually 20 to 50 years old. Late-successional forests consist of trees larger than 24 inches in diameter and typically exhibit a multi-storied structure. These forests may be as young as 40 years but exhibit these characteristics more typically starting at 50 to 60 years. Old-growth stands are variable and difficult to characterize, other than that they have not been harvested.

The majority of PALCO's grassland habitat is determined by edaphic and elevational factors. Most of this acreage cannot be modified by management and will remain in its current form. Some grasslands are the product of historical attempts to convert forested areas into pasture and may be allowed to revert to forest. Stands dominated by hardwoods tend to occur in drier and higher sites, but in some cases these can be modified by management. The most common habitat types resulting from PALCO's management activities are young- and mid-seral conifer stands.

To check on the legitimacy of this way of categorizing habitats, we turned to the biodiversity survey. These data have significant limitations. While they were gathered with a clear statistical purpose (McKenzie, et al. 1989) and avoid many of the most common sampling biases, 1995 was the first year for this survey, and some start-up problems occurred. Even had they not, one must expect a substantial amount of statistical noise in a sampling effort such as this. And, of course, the results of the survey can only be extended to those species likely to be detected by the sampling methods employed. Nocturnal birds and bats, for example, had little chance of entering into the resultant species lists.

We gave the biodiversity data an initial statistical analysis using the multivariate technique of cluster analysis with complete linkage. The initial analysis sought to look for natural groupings of habitat types by the vertebrate and plant species they shared. The results indicated that watersheds, the gross habitat categories (grassland, hardwood, seral stages), and perhaps distance to water were associated with the major clusters of samples. This suggested to us that the habitat categories were meaningful from the perspective of the biota itself.

We looked at the total number of species found in the biodiversity surveys in each of six habitat types. The pattern displayed in figure F-1 shows that forested habitats contained the most species, although no clear dominance can be seen among forest-habitat types in the overall number of species observed in each. To probe more closely, we compared the results of a subset of the biodiversity surveys, the breeding bird surveys, to lists of neotropical migratory birds provided by the Western Working Group of Partners In Flight. The species from these lists that are associated with a limited range of seral stages on PALCO's lands are displayed in figure F-2. The most striking aspect of this figure is that, at least for neotropical migrants, the habitats provided by young forests appear to provide the most value. Not only do these habitats support the most species, they also support the most species at moderate risk. The forests of least value to moderate-risk species are mid-seral Douglas-fir and old-growth redwood.

The first year's biodiversity work was a pilot study. Its weaknesses made it desirable to compare its results to other studies. Such a comparison is made difficult by the fact that nearly all previous scientific studies in this region have concentrated on the Douglas-fir forest type dominant

on the national forests. PALCO's forests are moister, lower elevation forests, mostly dominated by redwood. Hansen, et al. (1991) concluded that "...the majority of plant and vertebrate animal species are relatively equally distributed among unmanaged young [50-150 years], mature [150-250 years], and old growth [>250 years] Douglas-fir forests." This conclusion emerged from a review of a series of studies, of birds (Raphael 1984), small mammals (Raphael 1984, Taylor et al. 1988), amphibians (Raphael 1984), and reptiles (Raphael 1984). Only reptile species richness was significantly different among forest-age classes, with more species occurring in young than in old stands. Two subsequent studies in northwestern-California Douglas-fir forests (Ralph et al. 1991, Raphael 1991) also concluded that forest-stand age had little effect on bird species diversity, although seral stage affected species composition and abundance. Other results have not been so clear. When the two earliest successional stages (grass/forb; shrub/sapling) were included in another analysis, the number of bird species increased by the third year after logging, to produce a shrub/sapling stage richer in species than either mature forest or the grass/forb stage (Hagar 1960). This was the same result predicted by the California WHR model (Verner & Boss 1980) and tested empirically by Raphael & Marcot (1986). In this field study, bird species diversity was observed to increase with seral progression.

Except for the study by Raphael (1984) all other studies of mammal species diversity in this region have revealed an increase in mean number of species with increasing successional age, with greatest species richness in mature and old-growth forests (Ralph et al. 1991, Raphael 1988, Raphael 1991, Raphael & Marcot 1986).

The herpetofauna in California Douglas-fir/hardwood forests typically exhibits dominance by a few species of salamanders (Welsh & Lind 1991). Welsh & Lind (1988) initially claimed that total herpetofaunal species diversity was greater in older forest age classes. Later studies led them to conclude that while species composition and abundance were influenced by stand age, seral stage did not have an effect on species diversity (Welsh & Lind 1991). The pattern seemed to be that after logging, certain amphibians were replaced by reptiles that prefer the open, drier, and warmer clearcuts. Old-growth stands did support a greater biomass of salamanders. Research by Raphael & Marcot (1986) suggested that both reptile and amphibian diversity increased with seral stage, but later studies by Raphael (1988, 1991) concurred, in part, with the Welsh & Lind results, finding that stand age does not affect amphibian species richness. Reptile diversity, however, was greatest in clearcuts, less in old-growth, and equally low in young and mature forest. As in other studies, the total number of amphibians was greatest in older forests, while reptiles were most abundant in clearcuts.

To summarize, the first-year biodiversity survey suggests that the grassland-hardwood-seral stage habitat classification is a meaningful one, but it did not discover any clear associations of species richness with a particular habitat type. The literature in northern California is equally ambiguous. And neither source of information is entirely reliable for PALCO's lands. The conservative conclusion at this time is that each seral stage in the successional growth of PALCO forests provides a series of habitats supporting an assemblage of plant and animal species. None is irrelevant, and none is dominant.

Habitat Guilds

Given that the biodiversity data support the division of PALCO's habitats into the coarse categories of grasslands, hardwoods, and five seral stages, we structured our search for natural

groups of species by those broad habitat types. Two independent analyses were done. The first was a reanalysis of the 1995 survey data, looking this time not at how sample plots grouped together according to the species they share but at how species grouped together by the sample plots they either shared or mutually avoided. The second analysis took the total species list from the survey and examined the scientific literature for evidence of habitat versatility.

Weaknesses in the biodiversity sampling effort have already been mentioned. A literature review, by comparison, synthesizes a number of research efforts over a large geographic area. Since some of these efforts would focus on discovering the precise habitat requirements of a species, they would be expected to provide a more accurate portrait of habitat requirements than local surveys could hope to discover. The down side of a literature review is that habitat requirements inferred from distant study sites are often difficult to translate to local circumstances. PALCO may have defined a mid-seral forest differently from a Forest Service biologist, for example. And even if it did not, such a forest in a moist low-elevation site may provide a different suite of sub-habitats from a higher elevation national forest.

It came as little surprise to us that an analysis of the 1995 data that lumps all species together fails to display meaningful patterns. One should not expect that species of birds associate with one another in the same ways as species of plants or salamanders. Because of limitations on the quality of these data, we focused the analysis on bird species. Birds are the most diverse group of vertebrates on this ownership and, as a rule, the most habitat specialized of the terrestrial vertebrates. The analysis used only the bird species in table 1 that occurred on two or more plots. We limited the analysis to avoid dominance by the rare species most subject to sampling error and understand that this choice assumes that habitat guilds can be adequately described by the more common species.

The statistical analysis again employed the multivariate technique of cluster analysis with complete linkage. Figures F3-F5 display the dendrograms or tree diagrams for the three watersheds surveyed. The species, displayed along the horizontal axis, are listed by the first letters of their common names and appear in the same sequences with their full names in tables 2-4. The tree diagrams reveal the tightness of the “linkages” among species, represented as the per cent disagreement among sample plots. The more that species co-occur or fail to co-occur in the same plots, the smaller will be their linkage distances. For an extreme example, two species that jointly occur in 16 plots on the Beer Bottle watershed and jointly fail to occur on the remaining 16 would have 0% disagreement and be linked right at the horizontal axis. If, on the other hand, the first species occurred in 16 plots and the second occurred only in the remaining 16, then the two would have 100% disagreement and be linked far above the x-axis.

The linkage patterns should be interpreted as follows, using the Camp watershed (figure F-3, table 3) as an example. At a coarse scale, e.g. a linkage distance of 0.6, the bird community divides into four groups. The first three represent different groups of widely distributed species on the ownership. All of these groups are forest generalists with respect to seral stage. They may be focused on somewhat different habitat elements, but these data are too coarse to reveal this. The fourth group consists of less-common species. Figure F-6 is an enlarged display of the cluster analysis of this group. At a linkage distance of 0.4, these birds divide into two sub-groups. The first contains a single bird, the red-breasted nuthatch, that can be classified as a mid-seral/late-seral/old-growth species, and a cluster of forest generalists that are not widely distributed on the ownership. The second group consists of two sub-groups that are specialists

on young-seral, mid-seral, and shrubby habitats. For birds the Camp watershed seems to be dominated by four large groups of generalists and three small and uncommon groups of semi-specialists.

Unfortunately this result does not speak clearly to the goal of identifying management guidelines for the amounts of the six habitat types. Even more frustrating is the fact that the other two watersheds (figures F-4 and F-5) show somewhat different patterns of linkage. One other study of this sort in northern California came up with equally ambiguous results (Ralph, et al. 1991). We suggest two reasons why habitat specialists do not fall out of the analysis easily. The first is that the scale of the sample plots is somewhat small. This may be remedied in subsequent years. The second is that the broad habitat categories of interest on this ownership are internally heterogeneous. Some late-seral stands are fairly uniform in age while others are uneven. Some young-seral stands are dominated by conifers while others are dominated by flowering shrubs. There is no way to remedy this.

The literature review of species was divided into two stages. The first consisted of a rating of the versatility of the species that might occupy this ownership with respect to the range of habitats of interest. The second step aggregated the species with low and moderate versatilities into habitat-related categories.

To score the versatility of animals, we began with an examination of the California Wildlife Habitat Relationships data base (Mayer and Laudenslayer 1988). Since the WHR system was explicitly designed to overstate the range of habitats a species will occupy, we chose to be cautious about its use for this purpose. If the WHR system reported that a species had low habitat versatility, we accepted that assessment. If it reported moderate or high versatility, then we verified that assessment with other information sources.

The WHR versatility rating was done as follows. The data base was first searched for all habitat types used for reproduction, feeding, or cover for all species on the list. This produced an excessively large array of habitats for each species. The list was narrowed by considering only habitats with moderate or high values for reproduction, feeding, or cover. Low versatility was defined as appearance in only one or two WHR categories. If the categories spanned seral stages, then they had to be adjacent categories. A moderate-versatility species appeared in three to four WHR categories. A high-versatility species used five to six.

Once the WHR analysis was complete, the moderate- and high-versatility species were re-examined by use of general reference works on vertebrate species of North America. When alternative sources were available, the references relied upon most heavily were those closest in geographic emphasis to the north coast of California. For birds these were Beedy and Granholm (1985), Clark and Wheeler (1987), Morrison, et al. (1985), National Geographic Society (1983), Peterson (1961), Shuford (1993), and Small (1994). For mammals these were Jameson and Peeters (1988) and Morrison et al. (1985). For amphibians and reptiles these were Behler and King (1979) and Stebbins (1985). In doing the literature search the versatility categories were redefined somewhat. High versatility meant the use of many different kinds of habitats, including different forest structures. Moderate versatility meant either the use of only one kind of plant community (redwood for example) or the use of many kinds of habitats, but the requirement of some factor unique to one or two seral stages. Low versatility meant a restriction to grasslands, hardwoods, or a single seral stage. The resultant versatility ratings are listed in table 5.

Once the versatility ratings were given, high-versatility species were classified as generalists and the medium- and low-versatility species were organized into groups related to PALCO's habitat categories (table 6). Where species occupied more than one category, the most common category was chosen. This effort resulted in two categories with few species (grassland, old-growth), two intermediate-sized categories (hardwood, shrub/forest opening/young seral), and three comparatively large categories (generalists, mid seral/late seral/old growth, riparian forest and shrub).

The two approaches, the biodiversity survey and the literature review, do not seem to coincide very well. If the two approaches measured the same thing, then one might expect the largest average per cent occurrence in the sample plots to be found in the species with the highest versatility and the smallest average per cent occurrence in the species with the lowest versatility. Figure F-7 displays the average per cent occurrence in sample plots for five versatility categories. Not only is there no clear positive relationship between versatility and per cent occurrence, there may, arguably, be a negative relationship. The explanation of this is probably that PALCO's lands do not provide nearly the full range of habitat types that ornithologists have in mind when they rate a species' versatility. This difference of scale can be coupled with the fact that PALCO's lands clearly provide a great deal of habitat for some species, and many of these are rated low to moderate in habitat versatility. For example, the most consistently found bird species in the surveys (Pacific-slope flycatcher) is rated as only a moderately versatile species in the literature review.

We suggest that neither approach to characterizing habitat guilds be taken in isolation at this time. The data from the biodiversity survey are still incomplete and excessively variable. Without reference to the broader literature they can be misleading. On the other hand, they do provide the most direct and unbiased information about the biotic communities on PALCO's lands. The literature search incorporates a much broader range of scientific consensus, and it is essential to the interpretation of some of the results of the biodiversity surveys. Until the biodiversity sampling program stabilizes, the habitat guilds in table 6 are reasonable working groups for those species sampled.

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Table 1: Vertebrate species that do or may occur on PALCO's lands. Species preceded with an "x" were observed during the biodiversity survey. Species followed by an asterisk are those whose reported geographic ranges do not overlap PALCO's lands but which may possibly occur there.

BIRDS

Acorn woodpecker	***Melanerpes formicivorus***
x Allen's hummingbird	***Selasphorus sasin***
American crow	***Corvus brachyrhynchos***
American dipper	***Ciniclus mexicanus***
x American goldfinch	***Carduelis tristis***
x American kestrel	***Falco sparverius***
American redstart*	***Setophaga ruticilla***
x American robin	***Turdus migratorius***
x Anna's hummingbird	***Calypte anna***
Bald eagle	***Haliaeetus leucocephalus***
x Band-tailed pigeon	***Columba fasciata***
Bank swallow*	***Riparia riparia***
Barn owl	***Tyto alba***
x Barn swallow	***Hirundo rustica***
Barred owl	***Strix varia***
Belted kingfisher	***Ceryle alcyon***
x Bewick's wren	***Thryomanes bewickii***
Black phoebe	***Sayornis nigricans***
Black-capped chickadee	***Parus atricapillus***
Black-crowned night heron	***Nycticorax nycticorax***
x Black-headed grosbeak	***Pheucticus melanocephalus***
x Black-throated gray warbler	***Dendroica nigrescens***
x Blue grouse	***Dendragopus obscurus***
x Brewer's blackbird	***Euphagus cyanocephalus***
x Brown towhee	***Pipilo fuscus***
x Brown creeper	***Certhia americana***
Brown-headed cowbird	***Molothrus ater***
x Bushtit	***Psaltriparus minimus***
x California quail	***Callipepla californica***
Canyon wren*	***Catherpes mexicanus***
Cassin's finch*	***Carpodacus cassinii***
Cattle egret*	***Bubulcus ibis***
x Cedar waxwing	***Bombycilla cedrorum***
x Chestnut-backed chickadee	***Parus rufescens***
x Chipping sparrow	***Spizella passerina***
Cliff swallow	***Hirundo pyrrhonota***
Common merganser	***Mergus merganser***
Common nighthawk	***Chodeiles minor***
Common poorwill*	***Phalaenoptilus nuttallii***
x Common raven	***Corvus corax***
x Common yellowthroat	***Geothlypis trichas***

x Cooper's hawk	***Accipiter cooperii***
x Dark-eyed junco	***Junco hyemalis***
x Downy woodpecker	***Picoides pubescens***
Dusky flycatcher*	***Empidonax oberholseri***
x European starling	***Sturnus vulgaris***
Evening grosbeak	***Coccothraustes vespertinus***
Flammulated owl	***Otus flammeolus***
x Fox sparrow	***Passerella iliaca***
x Golden eagle	***Aquila chrysaetos***
x Golden-crowned kinglet	***Regulus satrapa***
Grasshopper sparrow	***Ammodramus savannarum***
x Gray jay	***Perisoreus canadensis***
Great blue heron	***Ardea herodius***
Great egret*	***Casmerodius albus***
Great horned owl	***Bubo virginianus***
Green heron	***Butorides virescens***
x Hairy woodpecker	***Picoides villosus***
Hammond's flycatcher*	***Empidonax hammondii***
Harlequin duck	***Histrionicus histrionicus***
x Hermit thrush	***Catharus guttatus***
x Hermit warbler	***Dendroica occidentalis***
Hooded oriole	***Icterus cucullatus***
House finch	***Carpodacus mexicanus***
House sparrow	***Passer domesticus***
x House wren	***Troglodytes aedon***
x Hutton's vireo	***Vireo huttoni***
x Lark sparrow	***Chondestes grammacus***
x Lazuli bunting	***Passerina amoena***
Lesser goldfinch	***Spinus psaltria***
x MacGillivray's warbler	***Oporornis tolmiei***
Marbled murrelet	***Brachyramphus marmoratus***
Marsh wren	***Cistothorus palustri***
x Mountain quail	***Oreortyx pictus***
x Mourning dove	***Zenaidura macroura***
x Nashville warbler	***Vermivora ruficapilla***
x Northern flicker	***Colaptes auratus***
Northern goshawk	***Accipiter gentilis***
Northern harrier	***Circus cyaneus***
Northern mockingbird*	***Mimus polyglottos***
Northern pygmy owl	***Glaucidium gnoma***
Northern rough-winged swallow	***Stelgidopteryx serripenis***
Northern saw-whet owl	***Aegolius acadicus***
x Olive-sided flycatcher	***Contopus borealis***
x Orange-crowned warbler	***Vermivora celata***
Osprey	***Pandion haliaetus***
x Pacific-slope (western) flycatcher	***Empidonax difficilis***
x Pileated woodpecker	***Dryocopus pileatus***
x Pine siskin	***Carduelis pinus***

Plain titmouse*	***Parus inornatus***
x Purple finch	***Carpodacus purpureus***
Purple martin	***Progne subis***
Pygmy nuthatch*	***Sitta pygmaea***
Red crossbill	***Loxia curvirostra***
x Red-breasted nuthatch	***Sitta canadensis***
x Red-breasted sapsucker	***Sphyrapicus ruber***
Red-shouldered hawk	***Buteo lineatus***
x Red-tailed hawk	***Buteo jamaicensis***
Red-winged blackbird	***Agelaius phoeniceus***
Rock dove	***Columba livia***
Rock wren	***Salpinctes obsoletus***
x Ruby-crowned kinglet	***Regulus calendula***
x Ruffed grouse	***Bonasa umbellus***
x Rufous hummingbird	***Selasphorus rufus***
x Rufous-sided towhee	***Pipilo erythrophthalmus***
Sharp-shinned hawk	***Accipiter striatus***
Snowy egret*	***Egretta thula***
x Solitary vireo	***Vireo solitarius***
x Song sparrow	***Melospiza melodia***
Spotted owl	***Strix occidentalis***
x Steller's jay	***Cyanocitta stelleri***
x Swainson's thrush	***Catharus ustulatus***
Townsend's solitaire	***Myadestes townsendi***
Turkey vulture	***Cathartes aura***
x Tree swallow	***Tachycineta bicolor***
x Varied thrush	***Ixoreus naevius***
x Vaux's swift	***Chaetura vauxi***
Violet-green swallow	***Tachycineta thalassina***
x Warbling vireo	***Vireo gilvus***
x Western bluebird	***Sialia mexicana***
x Western meadowlark	***Sturnella neglecta***
Western screech owl	***Otus kennicottii***
x Western tanager	***Piranga ludoviciana***
x Western wood pewee	***Contopus sordidulus***
White-breasted nuthatch*	***Sitta carolinensis***
x White-crowned sparrow	***Zonotrichia leucophrys***
White-tailed kite	***Elanus leucurus***
Wild turkey	***Meleagris gallapavo***
x Wilson's warbler	***Wilsonia pusilla***
x Winter wren	***Troglodytes troglodytes***
Wood duck	***Aix sponsa***
x Wrentit	***Chamaea fasciata***
x Yellow warbler	***Dendroica petechia***
Yellow-breasted chat	***Icteria virens***
x Yellow-rumped warbler	***Dendroica petechia***

MAMMALS

x Allen's (shadow) chipmunk	***Tamias senex***
x (American) Badger	***Taxidea taxus***
Beaver*	***Castor canadensis***
Big brown bat	***Eptesicus fuscus***
x Black bear	***Ursus americanus***
Black rat	***Rattus rattus***
x Black-tailed jackrabbit	***Lepus californicus***
x Bobcat	***Lynx rufus***
x Botta's pocket gopher	***Thomomys bottae***
x Broad-footed mole	***Scapanus latimanus***
Brown (Norway) rat	***Rattus norvegicus***
Brush mouse*	***Peromyscus boylii***
x Brush rabbit	***Sylvilagus bachmani***
Bushy-Tailed Woodrat*	***Neotoma cinerea***
x California ground squirrel	***Citellus beecheyi***
California kangaroo rat*	***Dipodomys californicus***
California myotis	***Myotis californicus***
x California red tree vole	***Arborimus pomo***
x Chickaree (Douglas' squirrel)	***Tamiasciurus douglasi***
x Coast mole	***Scapanus orarius***
x Coyote	***Canis latrans***
x Deer mouse	***Peromyscus maniculatus***
x Dusky-footed woodrat	***Neotoma fuscipes***
Elk	***Cervus elaphus***
x Fisher	***Martes pennanti***
Fox squirrel*	***Sciurus niger***
Fringed myotis	***Myotis thysanodes***
x Golden-mantled squirrel	***Citellus lateralus***
x Gray fox	***Urocyon cinereoargenteus***
Guano bat	***Tadarida brasiliensis***
Hoary bat	***Lasiurus cinereus***
x House mouse	***Mus musculus***
Little brown myotis	***Myotis lucifugus***
Long-eared myotis	***Myotis evotis***
Long-legged myotis	***Myotis volans***
x Long-tailed vole	***Mirotus longicaudus***
Long-tailed weasel	***Mustela frenata***
Marsh shrew	***Sorex bendirii***
Marten*	***Martes americana***
Mink	***Mustela vison***
x Mountain beaver	***Aplodontia rufa***
Mountain lion	***Felis concolor***
x Mule deer	***Odocoileus hemionus***
Muskrat*	***Ondatra zibethicus***
x Northern flying squirrel	***Glaucomys sabrinus***
x Oppossum	***Didelphis marsupialis***
x Oregon vole	***Microtus oregoni***

x Pacific jumping mouse	***Zapus trimotatus***
x Pacific shrew	***Sorex pacificus***
x Pacific water (water) shrew	***Sorex bendire***
Pallid bat*	***Antrozous pallidus***
x Pinyon mouse	***Peromyscus truei***
Porcupine*	***Erethizon dorsatum***
x Raccoon	***Procyon lotor***
x Red-backed vole	***Clethrionomys occidentalis***
Red bat	***Lasiurus borealis***
Red fox*	***Vulpes vulpes***
Redwood chipmunk	***Tamias ochrogenys***
x Ringtail	***Bassariscus astutus***
River otter	***Lutra canadensis***
x Short-tailed weasel	***Mustela erminea***
x Shrew mole	***Neurotrichus gibbis***
Silver-haired bat	***Lasionycteris noctivagans***
Sonoma chipmunk*	***Tamias sonomae***
x Spotted skunk	***Spilogale putorius***
x Striped skunk	***Mephitis mephitis***
Townsend's long-eared bat	***Plecotus townsendii***
Townsend's mole*	***Scapanus townsendii***
Townsend's vole	***Microtus townsendii***
x Trowbridge's shrew	***Sorex trowbridgei***
x Vagrant shrew	***Sorex vagrans***
x Western gray squirrel	***Sciurus griseus***
x Western harvest mouse	***Reithrodontomys megalotis***
Western pipistrel	***Pipistrellus hesperus***
White-footed vole	***Arborimus albipes***
x Wild pig	***Sus scrofa***
Wolverine*	***Gulo gulo***
Yuma myotis	***Myotis yumanensis***

AMPHIBIANS

x Arboreal salamander	***Aneides lugubris***
x Black salamander	***Aneides flavipunctatus***
Bullfrog	***Rana catesbeiana***
x California slender salamander	***Batrachoseps attenuatus***
x Clouded salamander	***Aneides ferreus***
Del Norte salamander*	***Plethodon elongatus***
Foothill yellow-legged frog	***Rana boylii***
x Northwestern salamander	***Ambystoma gracile***
x Oregon/Painted ensatina	***Ensatina eschscholtzii***
x Pacific giant salamander	***Diacamptodon ensatus***
x Pacific tree frog	***Hyla regilla***
x Red-legged frog	***Rana aurora***
Red-bellied newt	***Taricha rivularis***
Rough-skinned newt	***Taricha granulosa***
Southern torrent salamander	***Rhyacotriton variegatus***

x Tailed frog	***Ascaphus truei***
Western toad	***Bufo boreas***

REPTILES

x Alligator lizard	***Gerrhonotus coeruleus***
California mountain kingsnake*	***Lampropeltis zonata***
x California red-sided garter snake (common garter snake)	***Thamnophis sirtalis***
Common kingsnake	***Lampropeltis getulus***
x Gopher snake	***Pituophis melanoleucus***
Northwestern garter snake*	***Thamnophis ordinoides***
Racer	***Coluber constrictor***
Ringneck snake	***Diadophis punctatus***
x Rubber boa	***Charina bottae***
Sagebrush lizard	***Sceloporus graciosus***
x Sharp-tailed snake	***Contia tenuis***
Southern alligator lizard	***Gerrhonotus multicarinatus***
Western aquatic garter snake	***Thamnophis couchii***
x Western fence lizard	***Sceloporus occidentalis***
Western pond turtle	***Clemmys marmorata***
Western rattlesnake	***Crotalus viridis***
x Western skink	***Eumeces skiltonianus***
x Western terrestrial garter snake	***Thamnophis elegans***
Western whiptail*	***Cnemidophorus tigris***

Table 2: Bird species occurrences by seral stage in Beer Bottle Watershed
Species appearing in two or more plots are listed in their order in the tree diagram (Fig. F-3).

Species	Old growth (4)	Late-seral (6)	Mid-seral (10)	Young-seral (8)	Opening (1)	Grassland (3)	Total plots (32)
Stellar's jay	4	5	7	5			21
Hermit warbler	3	5	8	2			18
Dark-eyed junco	2	6	4	5	1	1	19
Wilson's warbler	3	2	7	6	1		19
Pacific-slope flycatcher	3	2	5	5	1		16
Warbling vireo	3	1	1	2	1		8
Red-breasted nuthatch	1	1	3	1			6
Golden-crowned kinglet	2	4	4				10
Chestnut-backed chickadee		4	4	3			11
Hutton's vireo	1		5	2			8
Hermit thrush	1	1	3	1			6
Winter wren		3	1	3			7
Song sparrow		2		3	1		6
Wrentit	1			5			6
Rufous hummingbird			1	3			4
Bewick's wren				2	1		3
Varied thrush	1	1	1	1			4
Northern flicker	1	1	1	1			4
Mourning dove		1		1			2
White-crowned sparrow				2			2
MacGillivray's warbler				2			2
California quail	1	1					2
Western bluebird		1	1			1	3
Pine siskin			1	1			2
American robin			1	1		1	3
Western meadowlark			1				2
Allen's hummingbird			1	1			2
Total species present	14	18	20	23	6	3	27

Table 3: Species occurrences by seral stage in Camp Watershed
Species appearing in two or more plots are listed in their order in the tree diagram (Fig. F-4)

Species	Old growth (5)	Late-seral (9)	Mid-seral (22)	Young-seral (6)	Total plots (42)
Winter wren	5	8	18		31
Golden-crowned kinglet	3	9	15		27
Wilson's warbler	5	9	19	6	39
Pacific-slope flycatcher	5	9	22	6	42
Chestnut-backed chickadee	3	7	14	4	28
Steller's jay	1	3	15	3	22
Dark-eyed junco	2	4	5	6	17
Brown creeper	5	5	9		19
Varied thrush	2	2	9	1	14
Hermit warbler	3	4	11	1	19
Hermit thrush	1	5	10	2	18
Red-breasted nuthatch	1		9		10
Pine siskin	1	1	3		5
Song sparrow			1	1	2
Red-tailed hawk		1	1	1	3
Orange-crowned warbler				2	2
Common raven	2				2
Bushtit		1	1	2	4
California quail		1	1	2	4
Swainson's thrush		4	4	5	13
Rufous hummingbird	1	3	4	5	13
Wrentit			6	6	12
Band-tailed pigeon		1	4	3	8
Olive-sided flycatcher		1	2	5	8
Hairy woodpecker		1	3	2	6
Hutton's vireo		3	6	2	11
Allen's hummingbird			4	3	7
Total Species	15	21	25	21	27

Table 4: Bird Species occurrences by seral stage in Elkhead Watershed. Species appearing in two or more plots are listed in their order in the tree diagram (Fig. F-5).

Species	Old growth (15)	Late-seral (1)	Mid-seral (10)	Young-seral (9)	Total plots (35)
Swainson's thrush	3	1	8	6	18
Song sparrow			8	8	16
Rufous hummingbird	7	1	9	7	24
Wilson's warbler	10	1	9	7	27
Pacific-slope flycatcher	15	1	10	9	35
Dark-eyed junco	9		7	7	23
Varied thrush	7				7
Hermit warbler	7		6	1	14
Steller's jay	8	1	4	3	16
Hairy woodpecker	5		4	4	13
Winter wren	7	1	5	2	15
Golden-crowned kinglet	8	1	3	1	13
Chestnut-backed chickadee	11	1	8	1	21
Brown creeper	11		9		20
Hermit thrush	4	1	4	3	12
Wrentit	2		2	8	12
Olive-sided flycatcher	2		2	3	7
Northern flicker	1	1		5	7
Red-breasted nuthatch	2		1		3
Fox sparrow			2	1	3
American robin			4		4
Western bluebird	1		1	1	3
Purple finch	1		1	2	4
House wren			2	3	5
White-crowned sparrow			1	2	3
American goldfinch				3	3
Common raven	3				3
Rufous-sided towhee			1	1	2
Ruby-crowned kinglet				2	2
Orange-crowned warbler				2	2
Chipping sparrow				2	2
California quail			1	4	5
Bewick's wren	1			2	4
Vaux's swift			3	1	4
Hutton's vireo	1			4	5
Allen's hummingbird				3	3

Total species	23	10	27	31	36

Table 5: Habitat versatility ratings (from the literature) for the vertebrate species present in PALCO's biodiversity surveys. "H" is high habitat versatility, a generalist species. "M" is moderate habitat versatility. "L" is low habitat versatility, a specialist species.

BIRDS	
Allen's hummingbird	M-H
American goldfinch	M-H
American kestrel	M-H
American robin	M
Anna's hummingbird	M-H
Band-tailed pigeon	M
Barn swallow	M
Bewick's wren	M
Black-headed grosbeak	M-H
Black-throated gray warbler	M-H
Blue grouse	M
Brewer's blackbird	H
Brown creeper	L-M
Brown towhee	M-H
California quail	M
Cedar waxwing	M-H
Chestnut-backed chickadee	M
Chipping sparrow	M-H
Common bushtit (bushtit)	M
Common raven	H
Common yellowthroat	M
Cooper's hawk	M-H
Dark-eyed junco	M-H
Downy woodpecker	M
European starling	M-H
Fox sparrow	M
Golden eagle	M-H
Golden-crowned kinglet	L-M
Gray jay	M
Hairy woodpecker	M
Hermit thrush	M
Hermit warbler	L-M
House wren	M-H
Hutton's vireo	L-M
Lark sparrow	M
Lazuli bunting	M
MacGillivray's warbler	M
Mountain quail	M
Mourning dove	H
Nashville warbler	M
Northern flicker (common flicker)	H
Olive-sided flycatcher	M
Orange-crowned warbler	M

Pacific-slope flycatcher	M
Pileated woodpecker	M
Pine siskin	M
Purple finch	M
Red-breasted nuthatch	M
Red-breasted sapsucker	M
Red-tailed hawk	M-H
Ruby-crowned kinglet	M-H
Ruffed grouse	M
Rufous hummingbird	M
Rufous-sided towhee	M-H
Solitary vireo	M
Song sparrow	M-H
Steller's jay	M-H
Swainson's thrush	M-H
Tree swallow	M
Varied thrush	M
Vaux's swift	M
Warbling vireo	M
Western bluebird	M
Western meadowlark	M
Western tanager	M
Western wood pewee	M-H
White-crowned sparrow	M-H
Wilson's warbler	M
Winter wren	M
Wrentit	L
Yellow warbler	M
Yellow-rumped warbler	H

MAMMALS

Allen's (shadow) chipmunk	M
Badger (American badger)	L-M
Black bear	H
Black-tailed jackrabbit	H
Bobcat	H
Botta's pocket gopher	H
Broad-footed mole	H
Brush rabbit	H
California ground squirrel	H
California red tree vole	L
Chickaree (Douglas' squirrel)	M
Coast mole	M
Coyote	H
Deer mouse	H
Dusky-footed woodrat	M
Fisher	M
Golden-mantled squirrel	H

Gray fox	H
House mouse	H
Long-tailed vole	H
Mountain beaver	M
Mule deer	H
Northern flying squirrel	L-M
Oppossum	H
Oregon vole	H
Pacific jumping mouse	M
Pacific shrew	M
Pacific water shrew (water shrew)	M
Pinyon mouse	H
Raccoon	H
Red-backed vole	M
Ringtail	H
Short-tailed weasel	H
Shrew mole	M
Spotted skunk	H
Striped skunk	H
Trowbridge's shrew	M
Vagrant shrew	M
Western gray squirrel	M
Western harvest mouse	M
Wild pig	M

AMPHIBIANS

Arboreal salamander	M
Black salamander	H
California slender salamander	H
Clouded salamander	M-H
Northwestern salamander	H
Oregon/Painted ensatina	H
Pacific giant salamander	M
Pacific tree frog	H
Red-legged frog	H
Tailed frog	H

REPTILES

Alligator lizard	H
California red-sided garter snake (common garter snake)	H
Gopher snake	H
Rubber boa	H
Sharp-tailed snake	H
Western terrestrial garter snake	H
Western fence lizard	H
Western skink	H

Table 6: Habitat guilds for the vertebrate species on PALCO's lands (inferred from the literature). Species preceded with an "x" were observed in the biodiversity sampling effort. Species labeled with an asterisk are those whose reported ranges do not overlap PALCO's lands, but which may possibly occur there. Species explicitly dependent on snags or cave-like structures (caves, hollow trees or snags, human structures) are indicated.

GRASSLAND

x American kestrel
x Barn swallow
Grasshopper sparrow
Northern harrier
x Western meadow lark
x Badger
x Western harvest mouse
Northwestern garter snake*

SHRUB/FOREST OPENING/YOUNG-SERAL

x American goldfinch
x American robin
x Bewick's wren
x Black-throated gray warbler
x Brown towhee
x Bushtit
x California quail
Common poorwill*
Dusky flycatcher*
x Fox sparrow
x House wren
x Lark sparrow
x Lazuli bunting
x MacGillivray's warbler
x Mountain quail
x Nashville warbler
x Olive-sided flycatcher
x Orange-crowned warbler
Purple martin (snags)
x Ruby-crowned kinglet
x Rufous hummingbird
x Rufous-sided towhee
x Western bluebird
x White-crowned sparrow
x Wrentit
Brush mouse*
California kangaroo rat*
x Coast mole
Porcupine*
Sonoma chipmunk*

MID-SERAL/LATE-SERAL/OLD GROWTH

Barred owl
Black-crowned night heron
x Blue grouse
x Brown creeper
Cassin's finch*
Cattle egret*
x Chestnut-backed chickadee
Common nighthawk
Evening grosbeak
Flammulated owl
x Golden-crowned kinglet
x Gray jay
Great blue heron
Great egret*
x Hairy woodpecker (snags)
Hammond's flycatcher*
x Hermit thrush
x Hermit warbler
Northern goshawk
Northern pygmy owl
Northern saw-whet owl
x Pileated woodpecker (snags)
x Pine siskin
Pygmy nuthatch*
Red crossbill
x Red-breasted nuthatch
x Red-breasted sapsucker
x Ruffed grouse
Sharp-shinned hawk
Snowy egret*
Spotted owl
x Steller's jay
Townsend's solitaire
Varied thrush
x Vaux's swift
x Western tanager
x Winter wren
x Allen's chipmunk
Bushy-tailed woodrat*
x California red-backed vole
x Chickaree
x Fisher
Hoary bat
Long-eared myotis
Marten*
x Northern flying squirrel
x Red tree vole

Redwood chipmunk
x Vagrant shrew
x Western gray squirrel
Wolverine*
x Clouded salamander

OLD GROWTH
Marbled murrelet

HARDWOOD
Acorn woodpecker
x Band-tailed pigeon
Plain titmouse*
x Purple finch
x Solitary vireo
x Warbling vireo
White-breasted nuthatch*
California myotis (caves)
Fox squirrel*
Red bat
x Wild pig
x Arboreal salamander
Western whiptail*

RIPARIAN FOREST AND SHRUB
American dipper
Bald eagle
Bank swallow
Belted kingfisher
Black-capped chickadee
Black phoebe
Canyon wren*
Common merganser
x Common yellowthroat
x Downy woodpecker (snags)
Green heron
Harlequin duck
Marsh wren
Osprey
x Pacific slope flycatcher
Red-shouldered hawk
x Tree swallow (snags)
x Wilson's warbler
Wood duck
x Yellow warbler
Yellow-breasted chat
Beaver*
Marsh shrew

Mink
x Mountain beaver
Muskrat*
x Pacific jumping mouse
x Pacific shrew
x Pacific watershrew
River otter
x Shrew mole
Townsend's vole
Western pipistrel (caves)
White-footed vole
Bullfrog
Del Norte salamander*
Foothill yellow-legged frog
x Pacific giant salamander
Red-bellied newt
Rough-skinned newt
Southern torrent salamander
California mountain kingsnake*
Western aquatic garter snake
Western pond turtle

GENERALISTS

x Allen's hummingbird
x Anna's hummingbird
American crow
American redstart*
Barn owl
x Black-headed grosbeak
x Brewer's blackbird
Brown-headed cowbird
x Cedar waxwing
x Chipping sparrow
x Cooper's hawk
Cliff swallow
x Common raven
x Dark-eyed junco
x European starling
x Golden eagle
Great horned owl
Hooded oriole
House finch
House sparrow
Lesser goldfinch
x Mourning dove
x Northern flicker
Northern mockingbird*
Northern rough-winged swallow

x Red-tailed hawk
Red-winged blackbird
Rock dove
Rock wren
x Song sparrow
x Swainson's thrush
Turkey vulture
Violet-green swallow
Western screech owl
x Western wood peewee
White-tailed kite
Wild turkey
x Yellow-rumped warbler
Big brown bat (caves)
x Black bear
Black rat
x Black-tailed jackrabbit
x Bobcat
x Botta's pocket gopher
x Broad-footed mole
Brown rat
x Brush rabbit
x California ground squirrel
x Coyote
x Deer mouse
x Dusky-footed woodrat
Elk
Fringed myotis (caves)
x Golden-mantled squirrel
x Gray fox
Guano bat (caves)
x House mouse
Little brown myotis (caves)
Long-legged myotis (caves)
x Long-tailed vole
Long-tailed weasel
Mountain lion
x Mule deer
x Oppossum
x Oregon vole
Pallid bat* (caves)
x Pinyon mouse
x Raccoon
Red fox*
x Ringtail
x Short-tailed weasel
Silver-haired bat (caves)
x Spotted skunk

x Striped skunk
x Townsend's mole
  Townsend's long-eared bat (caves)
x Trowbridge's shrew
  Yuma myotis (caves)
x Black salamander
x California slender salamander
x Northwestern salamander
x Oregon/Painted ensatina
x Pacific tree frog
x Red-legged frog
x Tailed frog
  Western toad
x Alligator lizard
x California red-sided garter snake
  Common kingsnake
x Gopher snake
  Racer
  Ringneck snake
x Rubber boa
  Sagebrush lizard
x Sharp-tailed snake
  Southern alligator lizard
x Western fence lizard
x Western skink
x Western terrestrial garter snake

Figure F-1: Number of Species Found

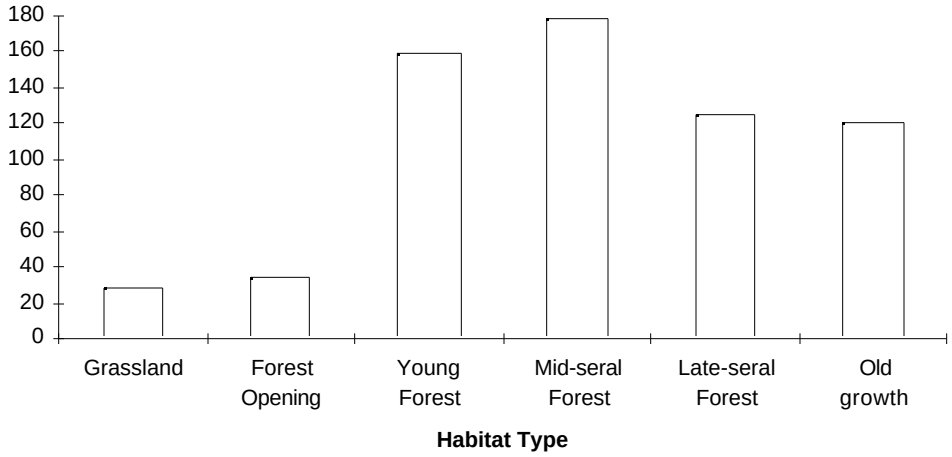
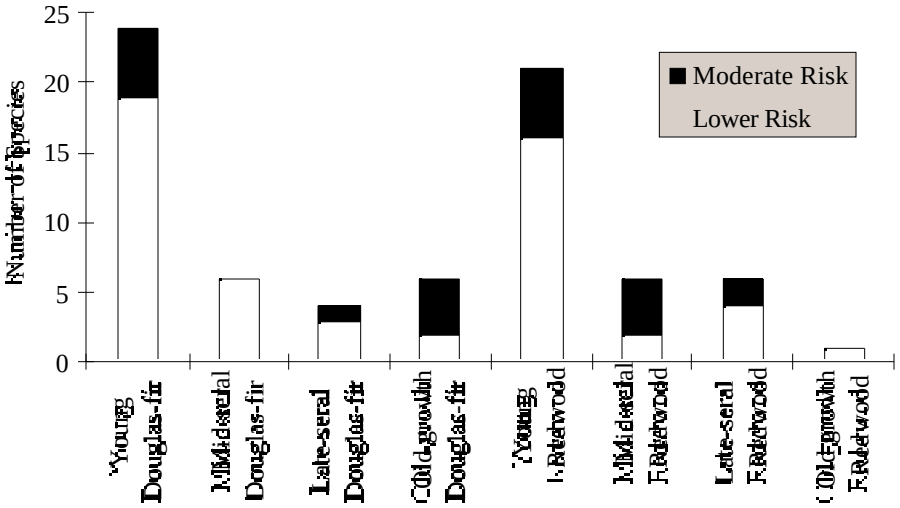
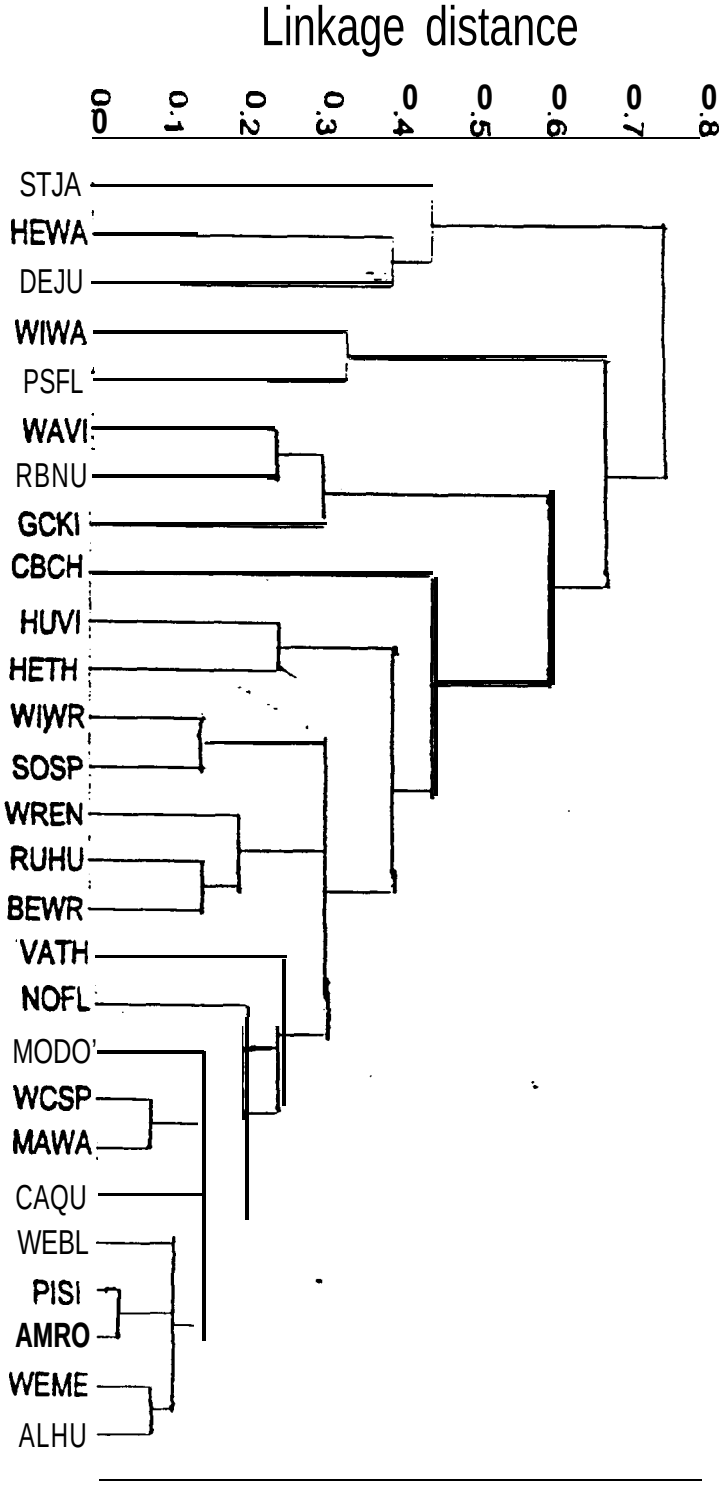


Figure F-2: Neotropical Migratory Birds
Associated with Forest Seral Stages



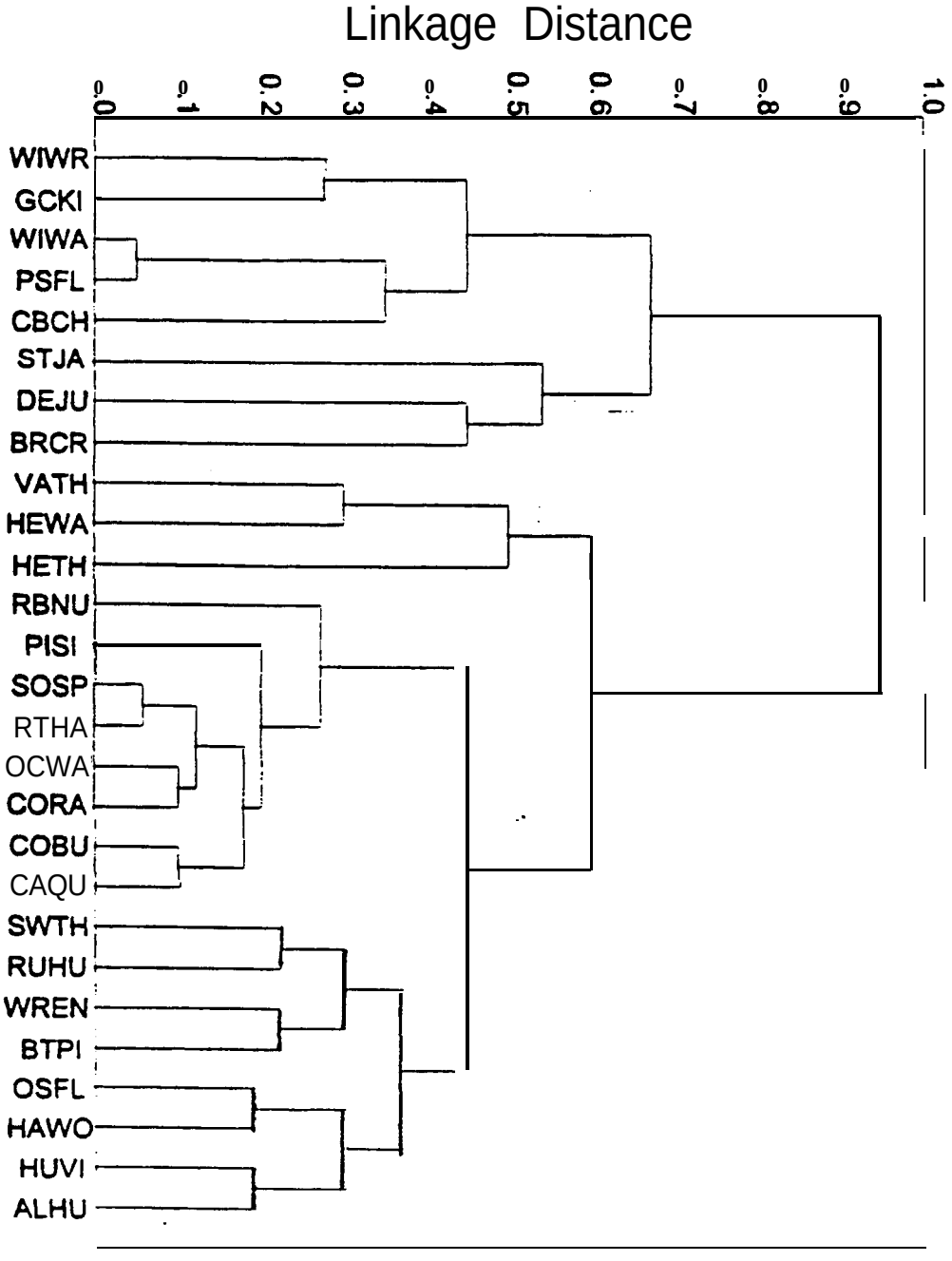
Data from Palco breeding bird surveys and Partners in Flight - Western Working Group

Figure F-3



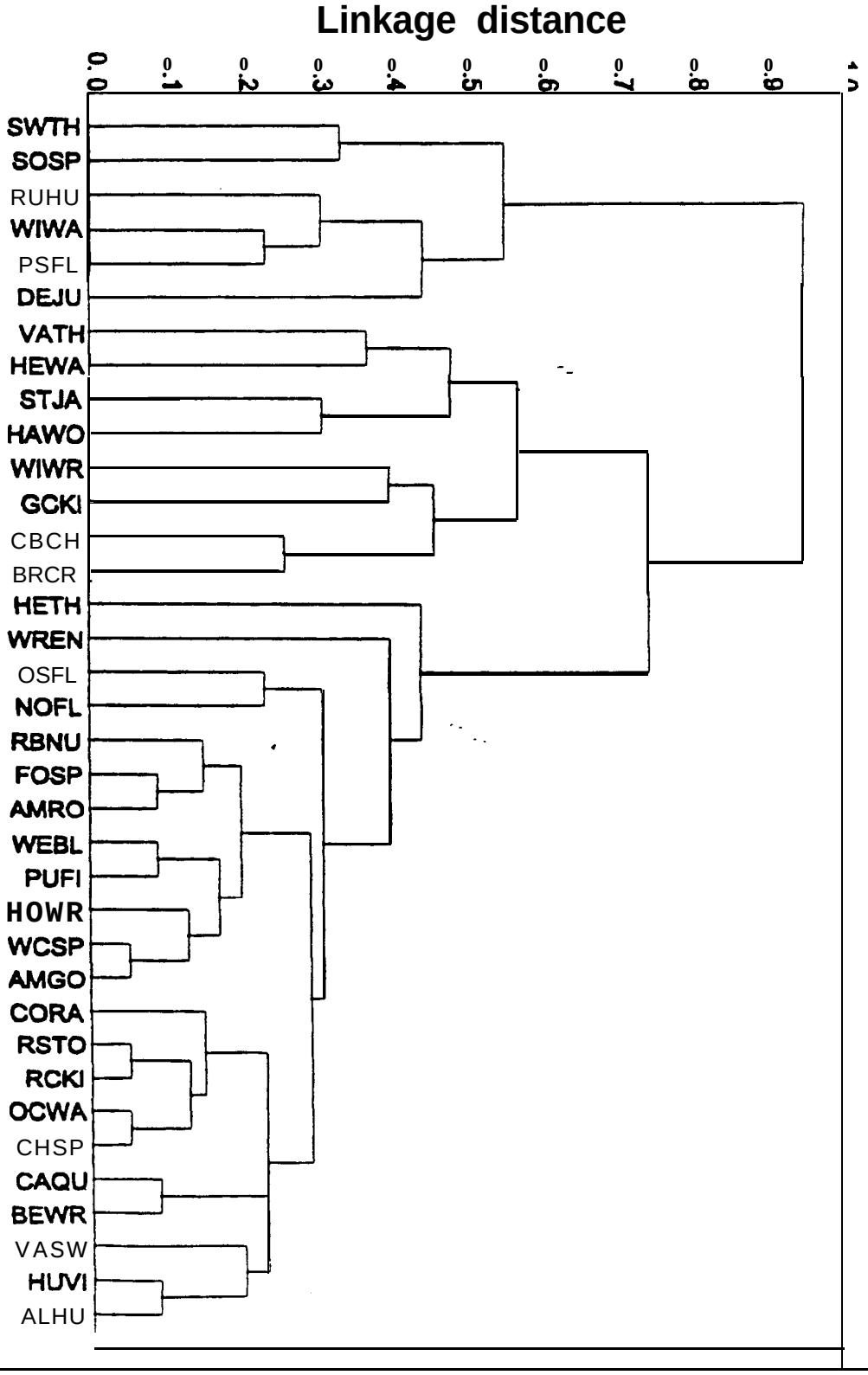
Tree diagram for the birds of Beer Bottle Watershed. The linkage distances represent per cent disagreement in a complete-linkage cluster analysis. The bird species are labeled by the first letters of their common names.

Figure F-4



Tree diagram for the birds of Camp Watershed. The linkage distances represent per cent disagreement in a complete-linkage cluster analysis.

Figure F-5



Tree diagram for the birds of Elkhead Watershed. The linkage distances represent per cent disagreement in a complete-linkage cluster analysis.

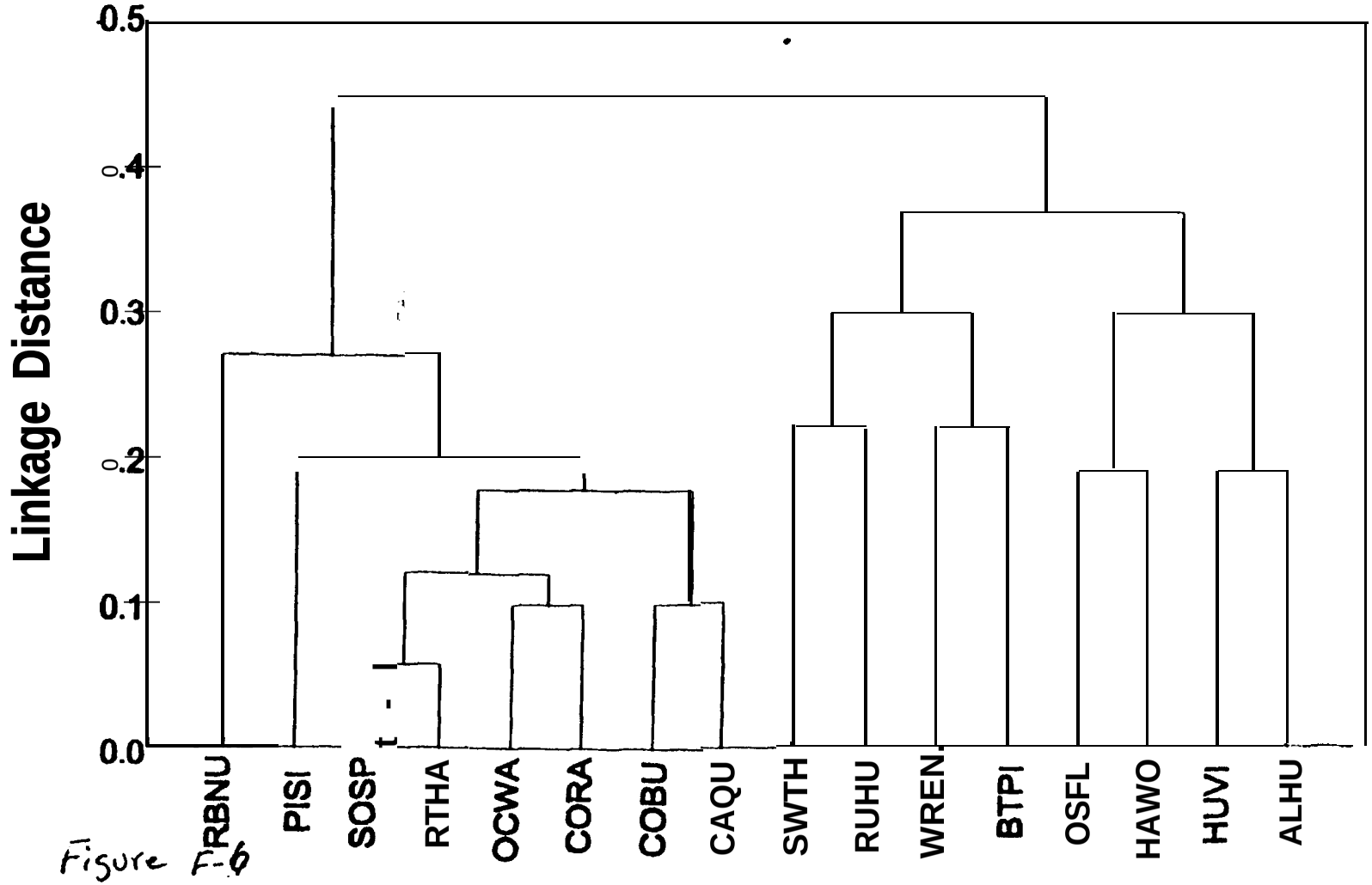
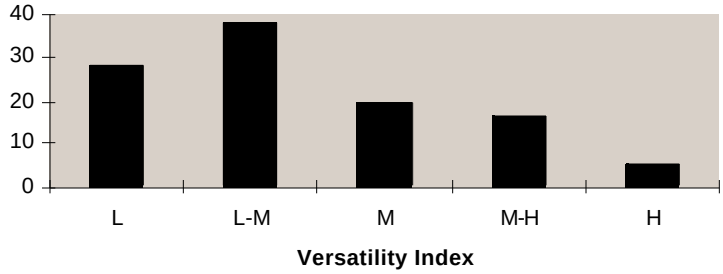


Figure F-6

Tree diagram for the rarer birds of Camp Watershed. The linkage distances represent per cent disagreement in a complete-linkage cluster analysis.

Figure F-7: Average Per Cent Occurrence



Habitat-based Plant Guilds

PLANT SPECIES/HABITAT-BASED GUILDS	
Primary Focus Species	**Secondary Focus Species**
COASTAL GUILD	
Abronia umbellata ssp. breviflora pink sand-verbena	***Calamagrostis bolanderi*** Bolander's reed grass
Boschniakia hookeri small groundcone	***Eleocharis parvula*** small spikerush
Calamagrostis crassiglumis Thurber's reed grass	***Hesperevax sparsiflora*** var. ***brevifolia*** short-leaved evax
Calamagrostis foliosa leafy reed grass	***Juncus supiniformis*** hair-leaved rush
Castilleja ambigua ssp. ***humboldtiensis*** Humboldt Bay owl's-clover	***Perideridia gairdneri*** ssp. ***gairdneri*** Gairdner's yampah
Castilleja mendocinensis Mendocino Coast Indian paintbrush	***Piperia michaelii*** Michael's rein orchid
Collinsia corymbosa round-headed Chinese houses	
Cordylanthus maritimus ssp. ***palustris*** Point Reyes bird's-beak	
Erigeron supplex supple daisy	
Erysimum menziesii ssp. ***eurekense*** Humboldt Bay wallflower	
Lathyrus palustris marsh pea	
Layia carnosa beach layia	
Lilium occidentale western lily	
Oenothera wolfii Wolf's evening-primrose	
Puccinellia pumila dwarf alkali-grass	
Sidalcea malachroides maple-leaved checkerbloom	
Sidalcea malvaeflora ssp. ***patula*** Siskiyou checkerbloom	
Viola palustris marsh violet	

GRASSLAND GUILD	
Castilleja mendocinensis Mendocino Coast Indian paintbrush	***Erigeron decumbens*** var. ***robustior*** robust daisy
Erigeron supplex supple daisy	***Fritillaria purdyi*** Purdy's fritillary
Lilium occidentale western lily	***Hemizonia congesta*** ssp. ***tracyi*** Tracy's tarplant
Monardella villosa ssp. ***globosa*** robust monardella	***Linanthus acicularis*** bristly linanthus
Sidalcea malachroides maple-leaved checkerbloom	***Melica spectabilis*** purple onion grass
Sidalcea malvaeflora ssp. ***patula*** Siskiyou checkerbloom	***Perideridia gairdneri*** ssp. ***gairdneri*** Gairdner's yampah
Tracyina rostrata beaked tracyina	***Wyethia longicaulis*** Humboldt County wyethia

SHRUB / FOREST OPENING / YOUNG SERAL	
Arctostaphylos canescens ssp. ***sonomensis*** Sonoma manzanita	***Arctostaphylos hispidula*** Howell's manzanita
Montia howellii Howell's montia	***Lilium kelloggii*** Kellogg's lily
Sanicula tracyi Tracy's sanicle	***Lilium rubescens*** redwood lily
Sidalcea malachroides maple-leaved checkerbloom	***Lilium washingtonianum*** ssp. ***purpurascens*** purple-flowered Washington lily
Thermopsis robusta robust false lupine	***Thermopsis gracilis*** slender false lupine

MID-SUCCESSIONAL / LATE SERAL / OLD GROWTH	
Boschniakia hookeri small groundcone	***Cypripedium montanum*** mountain lady's-slipper
Lycopodium clavatum running-pine	***Lilium kelloggii*** Kellogg's lily
Monotropa uniflora Indian-pipe	***Lilium rubescens*** redwood lily
Montia howellii Howell's montia	***Lilium washingtonianum*** ssp. ***purpurascens*** purple-flowered Washington lily
Sanicula tracyi Tracy's sanicle	***Listera cordata*** heart-leaved twayblade
Sidalcea malachroides maple-leaved checkerbloom	***Piperia candida*** white-flowered rein orchid
Sidalcea malvaeflora ssp. ***patula*** Siskiyou checkerbloom	***Piperia michaelii*** Michael's rein orchid
	Pityopus californicus California pinefoot
	Ribes laxiflorum trailing black currant
	Tiarella trifoliata var. ***trifoliata*** trifoliate laceflower

OLD GROWTH GUILD	
Boschniakia hookeri small groundcone	***Listera cordata*** heart-leaved twayblade
Monotropa uniflora Indian-pipe	***Pityopus californicus*** California pinefoot

HARDWOOD GUILD	
Astragalus agnicidus Humboldt milk-vetch	***Astragalus umbraticus*** Bald Mtn. milk-vetch
Boschniakia hookeri small groundcone	***Cypripedium montanum*** mountain lady's-slipper
Monardella villosa ssp. ***globosa*** robust monardella	***Erigeron bioletti*** streamside daisy
Monotropa uniflora Indian-pipe	
Sanicula tracyi Tracy's sanicle	***Lathyrus glandulosus*** sticky pea
Sidalcea malachroides maple-leaved checkerbloom	***Lilium rubescens*** redwood lily
Thermopsis robusta robust false lupine	***Linanthus acicularis*** bristly linanthus
Tracyina rostrata beaked tracyina	***Perideridia gairdneri*** ssp. ***gairdneri*** Gairdner's yampah
	Piperia michaelii Michael's rein orchid
	Pityopus californicus California pinefoot
	Thermopsis gracilis slender false lupine

RIPARIAN FOREST AND WETLAND GUILD	
Bensoniella oregona bensoniella	***Astragalus rattanii*** var. ***rattanii*** Rattan's milk-vetch
Carex leptalea flaccid sedge	***Calamagrostis bolanderi*** Bolander's reed grass
Carex praticola meadow sedge	***Erigeron biolettii*** streamside daisy
Epilobium oreganum Oregon fireweed	***Iliamna latibracteata*** California globe mallow
Glyceria grandis American manna grass	***Listera cordata*** heart-leaved twayblade
Lathyrus palustris marsh pea	***Lycopus uniflorus*** northern bugleweed
Lilium occidentale western lily	***Melica spectabilis*** purple onion grass
Lycopodium clavatum running-pine	***Pleuropogon refractus*** nodding semaphore grass
Microseris borealis northern microseris	***Ribes laxiflorum*** trailing black currant
Montia howellii Howell's montia	***Tiarella trifoliata*** var. ***trifoliata*** trifoliate laceflower
Sanguisorba officinalis ssp. ***microcephala*** great burnet	
Sidalcea malachroides maple-leaved checkerbloom	

GENERALIST GUILD	
Calamagrostis foliosa leafy reed grass	***Cypripedium californicum*** California lady's-slipper
Hesperolinon adenophyllum glandular western flax	***Cypripedium fasciculatum*** clustered lady's-slipper
Thlaspi californicum Kneeland Prairie pennycress	***Epilobium septentrionale*** Humboldt County fuchsia
	Erigeron biolettii streamside daisy
	Sedum laxum ssp. ***flavidum*** pale yellow stonecrop
	Tauschia glauca glaucous tauschia

Notes

Coastal Guild: This guild includes the immediate coastal habitat types, such as Coastal Dunes, Coastal Bluffs, Coastal Scrub, Coastal Marshes, and Sitka Spruce Forest.

Generalist Guild: This guild comprises species associated with rock habitat types and species commonly restricted to serpentine substrates.